

CLAIMS

What is claimed is:

- 5 1. A method for obtaining torques to be applied to joints of a leg of a biped walking system, comprising the steps of:
- determining which leg or legs are in contact with the ground;
  - obtaining an attitude of the leg;
  - obtaining the vertical component of acceleration of the center of
  - 10 gravity of the whole body including the leg;
  - obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground, the attitude of the leg and the vertical component of acceleration of the center of gravity of the whole body including the leg;
  - 15 obtaining a point of application of the ground reaction force;
  - obtaining moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and
  - 20 without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity; and
  - obtaining the torques to be applied to the joints of the leg, based on the moments acting around the joints of the leg.
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2. A method according to claim 1, wherein in the step of determining which leg or legs are in contact with the ground, the determination is made based on a value of the vertical component of acceleration measured on the body.
- 30 3. A method according to claim 1, wherein in the step of determining which leg

or legs are in contact with the ground, the determination is made using a sensor.

4. A method according to any one of claims 1 to 3, wherein in the step of  
5 obtaining a point of application of the ground reaction force, the point is  
obtained based on the attitude of the leg and a location of the center of gravity  
of the body.

5. A method according to claim 4, wherein in the step of obtaining a point of  
10 application of the ground reaction force, the point is obtained further using  
information from a sensor.

6. A method according to any one of claims 1 to 5, wherein the vertical  
component of acceleration of the center of gravity of the whole body, is  
15 obtained based on locations of the centers of gravity of portions of the body,  
obtained based on attitudes of the leg and other portions of the body, and the  
vertical component of acceleration measured at the body.

7. A method according to any one of claims 1 to 6, wherein in the step of  
20 obtaining moments acting around the joints of the leg, at first the vertical  
component of a force acting on and a moment acting around the knee joint of  
the shin, are obtained using the vertical component of the ground reaction  
force acting on the shin at the point of application of the ground reaction force  
and a term of the acceleration of gravity and without using the horizontal  
25 component of the ground reaction force and a term of acceleration except the  
term of the acceleration of gravity and then the vertical component of a force  
acting on and a moment acting around the hip joint of the thigh, are obtained  
using the vertical component of a force acting on and a moment acting around  
the knee joint of the thigh and a term of the acceleration of gravity without  
30 using the horizontal component of the horizontal component of the force acting

on the knee joint and a term of acceleration except the term of the acceleration of gravity.

8. A method for obtaining moments acting around joints of a leg of a biped walking system, comprising the steps of:

determining which leg or legs are in contact with the ground;

obtaining an attitude of the leg;

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground, the vertical component of acceleration of the center of gravity of the whole body including the leg and the attitude of the leg;

obtaining a point of application of the ground reaction force; and

obtaining the moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity.

9. A processor for obtaining torques to be applied to joints of a leg of a biped walking system, the processor being operable in association with angular sensors on the joints and at least one accelerometer set on the body of the biped walking system, wherein the processor is configured to perform the steps of:

determining which leg or legs are in contact with the ground, using information from the at least one accelerometer;

obtaining an attitude of the leg, using information from the angular sensors;

obtaining a location of the center of gravity of the whole body including

the leg;

obtaining the vertical component of acceleration of the center of gravity of the whole body including the leg, using information from the at least one accelerometer;

5 obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground, the attitude of the leg, the location of the center of gravity of the whole body and the vertical component of acceleration of the center of gravity of the whole body;

10 obtaining a point of application of the ground reaction force, using the attitude of the leg and the location of the center of gravity of the whole body;

obtaining moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and  
15 without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity; and

obtaining the torques to be applied to the joints of the leg, based on the moments acting around the joints of the leg.

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10. A processor for obtaining torques to be applied to joints of a leg of a biped walking system, the processor being operable in association with angular sensors on the joints, at least one accelerometer set on the body of the biped walking system and at least one sensor set on the leg, wherein the processor is  
25 configured to perform the steps of:

determining which leg or legs are in contact with the ground, using information from the at least one sensor set on the leg;

obtaining an attitude of the leg, using information from the angular sensors;

30 obtaining a location of the center of gravity of the whole body including

the leg;

obtaining the vertical component of acceleration of the center of gravity of the whole body including the leg, using information from the at least one accelerometer;

5 obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground, the attitude of the leg, the location of the center of gravity of the whole body and the vertical component of acceleration of the center of gravity of the whole body;

obtaining a point of application of the ground reaction force, using the  
10 attitude of the leg and the location of the center of gravity of the whole body;

obtaining moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and  
15 without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity; and

obtaining the torques to be applied to the joints of the leg, based on the moments acting around the joints of the leg.

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11. A processor for obtaining moments acting around joints of a leg of a biped walking system, the processor being operable in association with angular sensors on the joints, at least one accelerometer set on the body of the biped walking system, wherein the processor is configured to perform the steps of:

25 determining which leg or legs are in contact with the ground, using information from the at least one accelerometer;

obtaining an attitude of the leg, using information from the angular sensors;

obtaining a location of the center of gravity of the whole body including  
30 the leg;

obtaining the vertical component of acceleration of the center of gravity of the whole body including the leg, using information from the at least one accelerometer;

5 obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground, the attitude of the leg, the location of the center of gravity of the whole body and the vertical component of acceleration of the center of gravity of the whole body;

obtaining a point of application of the ground reaction force, using the attitude of the leg and the location of the center of gravity of the whole body;  
10 and

obtaining the moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and  
15 without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity.

12. A processor for obtaining moments acting around joints of a leg of a biped  
20 walking system, the processor being operable in association with angular sensors on the joints, at least one accelerometer set on the body of the biped walking system and at least one sensor set on the leg, wherein the processor is configured to perform the steps of:

determining which leg or legs are in contact with the ground, using  
25 information from the at least one sensor set on the leg;

obtaining an attitude of the leg, using information from the angular sensors;

obtaining a location of the center of gravity of the whole body including the leg;

30 obtaining the vertical component of acceleration of the center of

gravity of the whole body including the leg, using information from the at least one accelerometer;

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground, the attitude of the leg, the location of the center of gravity of the whole body and the vertical component of acceleration of the center of gravity of the whole body;

obtaining a point of application of the ground reaction force, using the attitude of the leg and the location of the center of gravity of the whole body; and

obtaining the moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity.